the gill-arches. Black pigment is present in the anterior part of its inner portion.

Epithelium.—The epithelium lining the mouth consists of polygonal cells, apparently without cilia. In the pharynx, nests of simple glands, like those of the tongue, are present; and, as already mentioned, numerous sense-organs are to be found in the region of the gill-clefts. The epithelial cells of the stomach and intestine are columnar, but vary much in their form and proportions. Cilia could be detected here and there; in all probability they occur in isolated regions, as in the adult lamprey.

With the exception of the large liver, there is no trace of any gland in connection with the stomach and intestine, and digestion must be thus performed largely through the instrumentality of leucocytes.

Muscles of the Alimentary Canal.—The muscles of the walls of both stomach and intestine are only very slightly developed in torpid specimens, and are apparently broken up and separated by the lymphatic tissue to be described presently. They probably, therefore, undergo a similar degeneration to that observed in the caudal muscles.

Lymphatic Organs of the Stomach and Intestine.—The form of these organs has been described by Ayers (*loc. cit.*) I have not been able to verify his supposition that there are direct connections between them and the lumen of the intestine. A central part of the lymphatic organ running down the axis of the spiral valve can be distinguished from the rest by its more compact structure. Many of the leucocytes in these regions are full of fat-globules.

A large lymphatic body is present behind the cloaca and pelvis, and probably serves to protect the vent from the entrance of harmful substances.

Cloacal Cæcum.—The so-called "urinary bladder" opens into the cloaca between the rectum and the urinary and generative ducts. It has therefore much the position of the "rectal gland" of Selachians, and probably has nothing to do with the urinary bladder of other forms.

Lungs.—The cavity of the lungs is divided up by trabeculæ, which give the anterior unpaired portion a sponge-like appearance: a central lumen is present in the paired portion. A large lymphatic organ lies beneath the anterior unpaired part, the curious relations of which I hope to describe later, and will now only mention that the blood corpuscles migrate from it into the tissues of the lung.

Abdominal Pores.—As Ayers has shown, only one abdominal pore is usually present, and in my sections this ends blindly, and does not open into the cœlome. Probably its relations vary in different individuals.

Blood Corpuscles.—The chief peculiarity of the blood of Protopterus is the large size of the corpuscles, and the comparatively large proportion of the white in comparison with the red. The form of the latter resembles that of the red corpuscles of Amphibians. In length they measure from 0·040–0·046 mm., and in width 0·025–0·027 mm. The size of the white corpuscles varies greatly. The diameter of the largest, when not throwing out pseudopodia, may exceed the length of a red corpuscle. Two kinds may be distinguished, as follows:—(1) Large leucocytes of the ordinary form, the protoplasm of which is usually distinctly differentiated into a coarsely granular endoplasm and a hyaline ectoplasm. In specimens prepared for me by Dr. Goldmann, according to Dr. Ehrlich's method, the protoplasm and nucleus are coloured violet. (2) Leucocytes of various sizes, the largest being usually rather smaller than those described above. The granules in the protoplasm are finer, and in addition to the ordinary blunt pseudopodia, stiff filamentous processes are also formed. The protoplasm of these stains brownish-red by Ehrlich's method, and Dr. Goldmann informs me that a similar coloration occurs in human white corpuscles in cases of leukæmia. Prof. August Gruber was kind enough to make a careful examination of these corpuscles with me, and we were able to trace a gradual disintegration in those described under (2), until finally nothing but the greatly altered nucleus is left. It seems probable, therefore, that these leucocytes convey the nutriment from the alimentary canal (or muscles) into the blood, and there disintegrate.

Blood-vessels.—I have at present only one or two remarks to make on the arrangement of the blood-vessels. Hyrtl's description [1] of the vessels of Lepidosiren would answer equally well in most points to Protopterus. Peters [2] describes a single pulmonary artery, arising from the efferent branchial vessels on the left side. This soon branches into two, each branch running along the inner side of the corresponding lung. No mention, however, is made by Peters of the corresponding right vessel, which has precisely the arrangement described by Hyrtl in Lepidosiren. This right pulmonary artery also divides into two, one branch passing along the dorsal surface of each lung alongside the pulmonary branch of the vagus.

The caudal vein divides up into two renal-portals. These are said by Hyrtl to anastomose anteriorly with a paired azygos in Lepidosiren. I have been unable to find any such "azygos vein" in Protopterus. The two so-called "venæ cavæ posteriores" doubtless correspond to the posterior cardinals, though they are somewhat modified. No lymphatic vessels could be detected.

Urinary Organs.—The kidneys are closely invested everywhere except on their dorsal side, by lymphoid and fatty tissue, which posteriorly forms a large median mass, plugging the end of the cœlome. No nephrostomes are present, as was supposed by Ayers.

A quantity of pigmented tissue on the outer and lower borders of the kidneys may possibly represent the adrenals.

Generative Organs.—Concerning the structure of the female generative organs, I have, as yet, little to add to the descriptions of former observers. No accurate account of the male organs exists, and I am inclined to think that the descriptions which have been given up to the present time referred to immature females, the generative organs of which might easily be taken for those of a male.

I have been able to distinguish no essential differences in external form between males and females: the latter are by far the more abundant.

Each testis has much the form and relations of an immature ovary, and, like the ovary, is invested along its free edge and sides with lymphatic and fatty tissue. Along its ventral surface a slight groove can be distinguished, at the bottom of which the spermatic duct lies. Posteriorly, the two ducts come to the surface, unite, and open by a common aperture on a papilla into the cloaca, just as in the female. In transverse sections, the seminiferous tubules can be seen opening into the ducts; in ripe specimens, fully formed spermatozoa can be seen in their lumina. I have, up to the present time, found nothing which could correspond to the remnant of a Müllerian duct, and, as the ureter undoubtedly must represent the mesonephric duct, there remains no other explanation of the duct of the testis than to suppose it to be the homologue of the Müllerian duct.

The form of the spermatozoa is very curious: they are carrot-shaped, and each is provided with two long cilia. They are very small, the length of the carrot-shaped head being only about 1/25 mm.

Most of the above observations were made in the Anatomical Institute in Freiburg i/B, where I have profited much by the kind help and advice of Prof. Wiedersheim.

August 31, 1888. W. NEWTON PARKER.

A more detailed examination of a male specimen, in which the spermatozoa were not yet ripe, has shown that distinct rudiments of the anterior parts of the Müllerian ducts are present. Each has an abdominal aperture, similar in form and position to that of the oviduct, and extends backwards for a short distance, tapering off before the level of the kidneys is reached. In sexually mature individuals, all traces of the Müllerian ducts appear to have vanished.

The duct of the kidney must therefore, as in Elasmobranchs, represent a special collecting-tube developed in connection with the posterior mesonephric tubules. W. N. P.

University College, Cardiff, October 27.

THE WHEAT CROP OF 1888.

SIR JOHN LAWES has communicated some interesting facts with regard to the wheat crop of the present year. It has been Sir John Lawes's endeavour for many years past to establish a statistical relation between the fluctuations of the yield of wheat upon his own well-known experimental field in Hertfordshire with the general average obtained over the United Kingdom. In order to do this he has selected certain plots and taken their average yields, and it is maintained that the result so obtained fairly represents the average yield over the United Kingdom.

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[1] *Abhandlungen d. böhm. Gesell. d. Wiss.*, 1845.

[2] *Müll. Arch. f. Anat.*, 1845.

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This conclusion is based upon observations extending over upwards of forty years, and has been rather forced upon the attention of Sir John Lawes, than assumed in the first instance.

The central position of Hertfordshire (at least with regard to England), and the medium character of the soil and climate, afford some reason for expecting an average yield; and the various treatments to which the selected plots have been subjected also assist to secure an average and representative result. The selected plots are five in number, each of which has been similarly treated for the last forty-five years, and all of them have carried wheat every year during this long period. One of these plots has remained continuously unmanured and has yielded on an average 13 bushels per acre, which, strange to say, is one bushel above the official average crop of the United States of America. One has been continuously manured with fourteen tons of farm-yard manure per acre, and has yielded an average of 33¾ bushels during the last thirty-six years. The remaining three selected plots have been treated with artificial manures upon a uniform and undeviating plan, and have yielded on an average respectively 32¾, 36½, and 36¾ bushels per acre taken also over a period of thirty-six years.

The mean average of all these five plots taken over this long period is 27⅜ bushels, and it is this *mean* which corresponds with, or at least closely approximates to, the average yield of the United Kingdom. The average yield of these five selected plots for the present year is 27⅝ bushels per acre, equal to 26⅞ bushels when calculated as of 61 pounds each. The average yield arrived at on the same principle last year was 28⅜ bushels per acre, showing a deficit this year as compared with last of 1½ bushel per acre. Again, comparing the result obtained from the Rothamsted standard plots with what is considered the usual standard average of 28 bushels per acre, the deficiency for the present year would appear to amount to 1⅛ bushel per acre only.

Sir John Lawes's general deduction that the selected plots at Rothamsted fairly represent in yield the average of the United Kingdom is certainly an assumption which might be objected to on scientific grounds. It is, however, as already pointed out, rather to be regarded as an ascertained fact than as a simple assumption, and from the evidence of a large number of years, the fluctuations of yield at Rothamsted may be regarded as a barometer, if we may so express it, of the parallel fluctuations throughout the United Kingdom.

Judged by the standard of the Rothamsted yields, the wheat crop of 1888 is only slightly below the received average of 28 bushels per acre.

It is well known to agriculturists that the harvest of 1879 was the worst which the present generation has witnessed, and during the dismal summer which has now ended, many persons expressed an opinion that the harvest of 1888 was likely to equal in badness that of 1879. This discouraging view has, however, happily been dispelled, and the harvest of 1888, although inferior in both quantity and quality to an average one, is not to be reckoned as disastrous.

One important feature of the harvest of 1888 is, however, its irregularity, and this has not only given rise to many conflicting opinions, but made it exceedingly difficult to arrive at the truth.

The opinion of Sir John Lawes is that upon farms where the condition of the land was defective, as well as upon all lands where there was an excess of artificial nitrogenous manure, there was less than the average produce; but that when the manurial conditions were more favourable there was more than an average produce. Thus the continuously unmanured plot yields only 10 bushels per acre instead of 13, the average of the preceding 36 years. The farmyard manure plot, on the other hand, yields 38 bushels, against an average of only 33¾ bushels. Lastly, the plot which receives an excessive amount of nitrogenous manures in the form of ammonia salts, as well as mineral substances, yields only 35¼ bushels, against its average of 36½ bushels. The result thus generally indicated is supported by experiments made beyond the list of the usually selected plots, and is in these experiments still more pronounced.

The economic conclusion arrived at by Sir John Lawes after carefully passing this evidence in review is that "Taking the average population of the United Kingdom for the harvest year 1888–89 at rather over 37¾ millions, the estimated requirements for consumption, at 5·56 bushels per head, would be about 26⅔ million quarters. The area under wheat is reported to have been 2,663,436 acres, or nearly 300,000 acres more than last year. This area, at 26⅞ bushels per acre, would yield nearly 9 million quarters (8,947,480), and deducting 2 bushels per acre for seed, there would remain rather over 8¼ million quarters (8,281,621) available for consumption, and there would therefore be required about 18⅓ million quarters (18,394,271) to be provided from stocks and import. It is admitted that the wheat crop not only of America, but of some other countries whence we derive supplies, will be below the average. But during the last two months of the past harvest year our imports were at the rate of 21 million quarters per annum, and there seems no reason to fear that there will be any difficulty in obtaining sufficient supplies."

ON THE INFLUENCE OF LIGHT UPON THE EXPLOSION OF NITROGEN IODIDE.[1]

THE statement of L. Gattermann in his recent paper (*Berichte d. deutsch. chem. Gesellsch.* xxi. 751; following up V. Meyer's paper in the same volume, p. 26) on nitrogen chloride, that its explosive decomposition may be brought about, or its susceptibility to explosion much increased, by exposure to bright light, has recalled to my mind the fact, which did not specially impress me at the time, that I myself undoubtedly observed the same relation several years ago in the case of nitrogen iodide.

In a paper on the preparation and composition of the latter substance, published in the first number of this *Journal* (April 1879), it was noted that on two occasions the product obtained with the composition NI_3 or N_2I_6 "exploded in some quantity *under water* with much violence and complete shattering of the vessel."

I remember distinctly that in one of these cases I had just carried to a window, through which the sun was shining, the beaker full of water at the bottom of which was the black sediment of iodide, and was gently stirring the liquid with a glass rod, holding the beaker up so as to look at it from below, when the rod touched the lower part of the side or the bottom of the vessel, and the explosion occurred.

In the other case the iodide was being washed with ice-cold water of ammonia, the vessel standing on a table exposed at the time to the direct rays of the sun. I do not remember with certainty what seemed to precipitate the explosion on this occasion, but I believe it was the pouring some fresh liquid, from the height of a few inches, on the black sediment of iodide which had just been partially drained by decantation.

Under ordinary circumstances nitrogen iodide, while *wet*, exhibits no extraordinary sensitiveness, and may be safely worked with, only becoming highly dangerous on drying, so that I have little doubt that bright sunshine was influential in bringing about these two explosions. J. W. MALLET.

University of Virginia, May 8, 1888.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Hill, now Master of Downing College, having resigned the Demonstratorship of Anatomy, a senior demonstrator and two junior demonstrators at £100 and £50 stipends, and a University lecturer on advanced human anatomy are to be appointed, providing four teachers for the aggregate stipend, £250, formerly received by the Demonstrator. Starvation pay this, considering the limited opportunities in Cambridge for supplementing the income of an anatomist.

A grant of £80 from the Worts Fund is recommended to be made to Mr. M. C. Potter, to enable him to make botanical researches and to collect specimens in Ceylon during the coming winter.

The old Chemical Laboratory being now vacant, it is to be altered into a Pathological Laboratory for Prof. Roy.

The new scheme of examinerships in natural science was passed last week; the chief features being the appointment of two examiners each in elementary biology and chemistry, to take the 1st M.B., and the "specials" for the ordinary B.A. The stipends are rearranged, and in addition to a fixed amount a proportionate sum per candidate is allotted to the examiners, 5*s.* for Tripos candidates, 4*s.* for 2nd M.B. physiology and anatomy, and 2*s.* for the rest. Thus the examiners in anatomy and physiology, if 100 candidates

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[1] Reprinted from the *American Chemical Journal*, vol. x. No. 4.

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